REVIEW OF THE LEPREAU II

ENVIRONMENTAL IMPACT STATEMENT

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1. INTRODUCTION

The purpose of this report is to provide to the Lepreau II Environmental Assessment Panel (EPA) an independent critical evaluation of the conclusions reached by Maritime Nuclear, in its Environmental Impact Statement (EIS), regarding the probability of upset conditions and the risks posed to humans and the environment.

Apart from the EIS, additional information was provided in six Supporting Documents, in - Compendium of Comments of the Lepreau-2 EIS and in the Lepreau-EIS ,S emental Information [1-9].

Comments in this report are also based on the author's experience as member of the former AECB Reactor Safety Advisory Committee (1976-1979), as member of the AECB Nuclear Safety Advisory Committee (1980-1983) and as researcher in the field of risk analysis of different energy sources [10-13].

Although the author has a general knowledge of the global risks posed to humans and the environment, the thrust of the report will be on radiological risks to humans.

Risk analysis is a relatively new branch of scientific knowledge. The next section will provide an introduction of this subject, which is intended to sharpen intuitive concepts, avoid misunderstandings and put things in a proper perspective. The following section will provide an historical background on the AECB approach to nuclear power plant safety. Section 4 contains comments on the EAP guidelines concerning difficulties in interpreting some of the specific questions. Section 5 is devoted to evaluating the conclusions reached in the EIS with regards to radiological risks to humans. Section 6 contains comments on the List of Deficiencies in the Point Lepreau-2 EIS, as identified by the EAP. Section 7 contains

comments on the Lepreau-2 EIS, Supplemental Information, as provided by Maritime Nuclear. Finally, Section 8 discusses some of the issues raised by other intervenors.

2. RISK ANALYSIS

Risk is usually defined as the probability of a harmful event. It is measured by the product of the frequency of the event (or combination of events resulting in the harmful outcome) by its consequences.

The consequences have to be specified because their range may vary, for humans, from anguish to death. Usually, the consequences refer to injuries (temporary disabilities, permanent disabilities and fatalities), illnesses (not fatal and fatal) and genetic changes.

The population at risk has also to be specified; usually one refers to workers and the general public, but the latter may mean, according to the purpose of the analysis, individuals most at risk in the vicinity of the area where the harmful event may take place, the total population in a specified region, the whole world population or even all future generations.

An event may be considered as real when there is sufficient data to measure its frequency, hypothetical when its probable frequency has to be calculated and incredible when its calculated frequency is so small (say less than one in a million years), that there is practically no chance to witness such an event.

Risk analysis is generally performed for four purposes : for risk assessment, for ensuring that risks are below regulatory limits, for comparison studies between choices of sites, designs or operational procedures and for cost-benefit evaluations.

In risk assessment, the degree of accuracy is strongly dependent on the models used in the calculations and on the available statistical data. Due to natural limitations in physical and biological models, as well as to uncertainties related to low frequency events with potentially large consequences, risk analysis is done for regulatory purposes, by using conservative models and by making allowance for a margin of large errors. For comparison studies, one generally uses crude models for the common part of the choices under consideration and more accurate ones for the characteristic features of these choices. Finally, cost-benefit evaluation implies a social judgment since dollar figures have to be equated to health risks.

3. AECB APPROACH TO NUCLEAR SAFETY. AN HISTORICAL BACKGROUND*

Safety criteria for licensing nuclear power plants were first enunciated in Canada during the late 50's and the early 60's. These criteria contained both a safety goal and general requirements to ensure that the safety goal was achievable. As the main concern was then - as today - to minimize the probability of accidents of large consequences, Laurence proposed that the probability of a "disastrous" accident should be less than 10^{-5} per year. He further proposed that this probability could be achieved by providing "protective devices" and "containment provisions" which were completely separate from the "process systems" and from each other. If this separation was sufficiently complete so that the probability of cross-linked failure was very small, then the probability of a "disastrous accident" could be determined by the product of the frequency of a serious failure in the process systems and the probabilities that the protective devices and containment provisions do not perform as intended.

*Material for this section was extracted from [13].

This approach was incorporated in the first Siting Guide [17] developed by the Atomic Energy Control Board in 1964, in conjunction with the acceptance of the proposed Pickering site. The Siting Guide set "reference dose limits" for individuals and total population for three conditions : (a) normal operations; (b) process failures; (c) process and protective failures. The Siting Guide also set maximum frequency limits for conditions (b) and (c). By setting both dose and frequency limits for two broad accident conditions (called hereafter "single" and "dual" accidents), AECB implicitly set risk criteria for normal and accident conditions of acceptable consequences (< 25 rem to the most exposed individual from the population) but ignored "triple" accidents, i.e. simultaneous failure of a process system and of two of the independent protective or containment systems, on the basis of their very low probability of occurrence (less than 3×10^{-6}/year). This approach permitted reasonable limits to be chosen: frequency of occurrence of significant faults in the process system were to be less than 1 per three years and the unavailability of the protective devices and of containment provisions (later, both called special safety systems) were to be each less than $10^{-2.5}$ (now, 10^{-3}*). The individual and collective dose limits (0.5 rem/yr for normal operation and single failures, 25 rem for dual failures; 10^4 man-rem and 10^6 man-rem for single and dual failures respectively) were chosen on the basis of comparative risk: the risk of leukemia, considered as the most significant radiological hazard, should be small with respect to its natural rate of occurrence.

The present requirements are summarized in Table 1.

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*This decreases the probability of a triple failure to 3×10^{-7}/yr.

TABLE I

AECL Siting Guide Reference Dose Limits
Normal Operation and Accident Conditions

Situation	Maximum Frequency	Maximum Individual Dose Limits	Maximum Total Population Dose Limits
Normal Operation	—	0.005 Sv/yr whole body 0.03 Sv/yr to thyroid	100 man-Sv/yr whole body 100 thyroid - Sv/yr
Single Failure (Process System)	1 per 3 years	As for normal operation	As for normal operation
Dual Failure (Process System and Safety System)	1 per 3×10^3 years	0.25 Sv whole body 2.5 Sv to thyroid	10^4 man - Sv whole body 10^4 thyroid - Sv

In intervening years, designers and regulators have specified secondary criteria to ensure that the basic criteria can be met. Some of these criteria are now common practice: diversity to ensure that there is more than one way to perform a function, redundancy to ensure that a single malfunction cannot disable a system, testability to ensure that the special safety systems meet the required availability standards, the use of reliable safety support systems, etc. Some other criteria are now under review, e.g. the required effectiveness of the emergency core cooling system, the required effectiveness of the containment and the testable definition of safety system reliability.

Finally, the Advisory Committee on Nuclear Safety, has recommended General Safety Requirements for Nuclear Plants which would provide a comprehensive and consistent basis for AECB licensing regulations for nuclear power plants in Canada [14]. The major changes from the present AECB Guidelines are indicated in Table II where six categories of failures have been considered (instead of two). These recommendations are now under consideration for implementation.

TABLE II

Proposed Risk Categories for Accident Analysis

Category	Individual Effective Dose Equivalent Interval, Sieverts	Sum of the Probabilities of Occurrence of Failures within the Corresponding Effective Dose Equivalent Interval (per reactor unit per year)
1	$0 - 10^{-2.5}$	3.33×10^{-1}
2	$10^{-2.5} - 10^{-2}$	10^{-1}
3	$10^{-2} - 10^{-1.5}$	10^{-2}
4	$10^{-1.5} - 10^{-1}$	10^{-3}
5	$10^{-1} - 10^{-0.5}$	10^{-4}
6	$10^{-0.5} - 1$	10^{-5}

For licensing, a systematic review of normal and accident conditions is presented, by a public utility, in a "Reactor Safety Report". This report is then analyzed to the satisfaction of the AECB staff, before an operating licence permit is granted by the Board.

Hundreds of events and sequences of events are analyzed in that report and in accompanying studies. Modern analytical tools (event trees, fault trees, reliability theory, etc.) are used to estimate probabilities of hypothetical events and their probable consequences. As mentioned before, conservative models and upper limits of estimated frequencies and consequences are used to ensure that the Siting Guide reference dose limits are not exceeded.

In addition to regulatory limits, AECL has set an "ALARA" target for normal operation. The ALARA acronym derives from the following statement by the International Commission on Radiological Protection (ICRP) : "All exposures should be kept as low as reasonably achievable, social and economic factors being taken into account". This statement is also called the ALARA principle.

The ALARA target is 1/100 of the regulatory limit.

Concerning the use of the ALARA principle, a word of caution is needed. The AECB has applied this principle for some well-known cases, such as reducing by a factor of 100 the regulatory individual dose limit for normal operation. The design and the operational procedures of present nuclear power plants include a good number of other risk reducing features*. Should AECB, or any other agency for that matter, "push" towards additional risk reducing measures ? If yes, to what extent ? The answer is that each case has to be carefully evaluated "economic and social considerations taken into account". The cautionary note here is to indicate that the tendency of reducing risk becomes increasingly uncertain in achievements and certainly more costly.

From Table I, one can derive the maximum expected values of risk to the most exposed individual. These are given in Table III, in Sieverts/reactor-year.**

As far as risks to the general public, AECB has set maximum total population dose limits for normal operation as well as for accident conditions. The population dose is calculated by integrating, i.e. adding, all individual doses which exceed 1/100th of the dose of the most exposed individual. Incidently, this procedure excludes widespread population risks and "committed" risks, i.e. risks deriving from the persistency of some long-lived radionuclides. The rationale of this procedure was the following :

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* The Sievert is a radiation dose unit. It is generally agreed that the probability of contracting a fatal cancer is approximately 10^{-2} per Sievert.

**One should keep in mind that the owner of a nuclear plant has also strong economic incentives to protect its investment.

TABLE III
Maximum Expected Values of Risk

Condition	Risk, Sieverts/Reactor-year
Normal operation, regulatory limit	5.0×10^{-3}
Normal operation, ALARA target	5.0×10^{-5}
Accident situations, AECB, Siting guide	1.75×10^{-3}
Natural background (for comparison purposes)	$\sim 1.0 \times 10^{-3}$

the neglected individual doses are much smaller than the doses from natural background and the uncertainties in calculations are too large for meaningful use of those figures. As calculations become more accurate, committed doses might be included.

Experience has shown, however, that individual dose limits are more stringent than population dose limits. In view of this fact and due to the difficulty of calculating total population doses in a reliable manner, the present tendency is to de-emphasize the population dose. For protection purposes, the meaningful parameter is the individual dose: if the individual is protected, the population is also protected. For site selection purposes, however, doses should be evaluated for the different alternatives, as one of several factors to be taken into account in the decision making process.

As previously mentioned, risk calculations for licensing purposes are conservative. More realistic calculations as performed in the most comprehensive generalized studies of reactor risks, the Reactor Safety Study (Rasmussen Study) in the USA and the German Risk Study show that when plotting "risk curves" in a frequency vs. consequences diagram, i.e. the frequency of events of consequences larger than a given value, these curves become very steep as the probability of an accident sequence decreases below about 10^{-6} per year (Fig. 1).

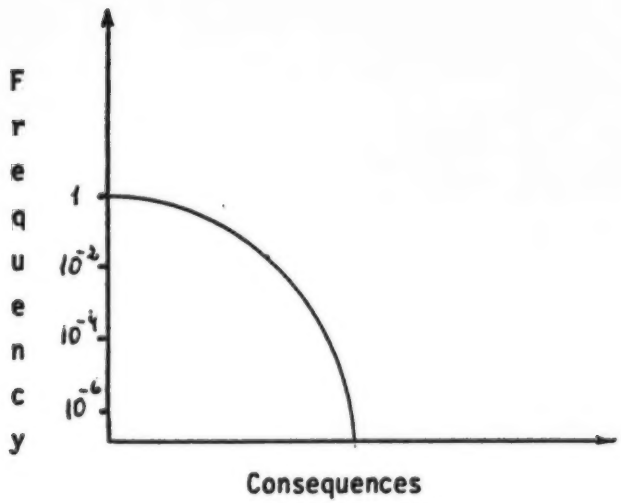

FIGURE 1. Frequency vs Consequences Diagram

This behaviour indicates relatively insignificant contributions to overall risk from potential accident sequences of probabilities less than about 10^{-6} per year. This behaviour also implies an upper limit to the magnitude of the consequences of any reactor accident which is not much greater than that associated with an event with a probability of 10^{-6} per year.

While no such comprehensive study of CANDU reactor risks has been undertaken, various studies of severe accident conditions in CANDU reactors indicate that there will be no fuel melting in a LOCA even with ineffective emergency coolant injection, which is not the case for a light water reactor. Thus, we would expect that the expected total probability of core melts would be less for a CANDU than for an LWR. Since the Reactor Safety Study and the German Risk Study show that there is no significant risk to the public unless core melting occurs, it is concluded that the overall risk associated with accident conditions in a CANDU will not be greater than that associated with accident conditions in an LWR. Therefore, the use of information from the American and Germain risk studies to establish safety criteria for CANDU reactors is justified.

4. COMMENTS ON THE EIS GUIDELINES

4.1 General comments

The EIS Guidelines provide a framework which allows the proponent to organize the material to satisfy the requirements of the Environmental Assessment Panel. For each of the six main issues, a number of concerns have been identified to which the proponent has been invited to address properly.

As expected, most of the issues refer to environmental impacts, in the broader sense. As the Panel seeks answers to a good number of questions, it is legitimate to pause and reflect on:

a) the degree of accuracy implied in the questions;

b) the amount of work asked to the proponent;

c) the criteria to be used by the Panel in order to consider the answers as satisfactory;

d) the relevancy of some of the questions with respect to the decision-making processes.

This should not be considered as a criticism of the Guidelines but only as a recognition of the difficulty of asking the relevant questions, i.e. questions which would allow satisfactory answers to be provided, within the present state of knowledge of physical, biological and human behaviour.

There should be no surprise to see the Panel, the proponent and other intervenors holding different views of these issues. What follows reflects the author's bias.

4.2 Comments on the Section on the biological impacts of radionuclides (Section 6.1.1)

Question 1a) refers to the "source terms". This information is relevant and readily available. Questions 1b) and 1c) refer to "pathway analysis". Also considerable information on this subject is available (certainly much more than for chemical pollutants), realistic models are in process of development both in Canada and other countries [15] and, as such, are still in the process of evaluation and validation. Since tens of radionuclides are implied and many pathways are to be considered, the answers to these questions are, by necessity, limited, and the accuracy of the results may have wide margins of errors (which does not necessarily mean that upper values cannot be estimated).

The question 1d), if taken literally, means commissioning a Canadian Reactor Safety Study. If taken in a limited sense, it may refer to accident analysis performed to satisfy AECB requirements, but this analysis is not amenable to give direct answers to the question. One can therefore easily foresee a qualitative answer provided by the proponent and a dissatisfaction expressed by the critics. The key issue here is the following: what additional information, if any, not included in the Reactor Safety Report, is needed and to what purpose ? If the purpose is the protection of environment (vegetal and animal life), a more appropriate question would have been to indicate probable harm, for a number of species, resulting from radioactive releases which would not exceed in humans the individual doses in Table I.

The question 1e) refers to the probability of releases capable of interupting the exploitation of food resources. While the amounts of such releases could be estimated, the probability of such events cannot be calculated in a meaningful way; the figure would be so low as to consider the event as "incredible". Again, a more meaningful question would have been: What are the consequences on food resources of releases considered as acceptable by the AECB ?

4.3 Comments on the Section on the radiation impacts on humans (Section 6.2)

The introductory statement in Section 6.2 recognizes that the nuclear power plant has to satisfy the AECB requirements but stresses the fact the the proponent has to show how it complies to respect the statutory limits and to apply the ALARA principle.

Questions 1, 2, 3, 5 and 6 are straightforward and the answers can be well documented. Question 4, however, raises, at best, the question of duplicating safety studies, at worse, the question of conflicting jurisdiction between the AECB and the EAP. As mentioned in the previous section, with respect to question 1d), the EAP seems to prefer the risk approach taken by the Rasmussen Report rather than the (deterministic) approach taken by the regulatory authorities both in USA and Canada.

While the author has expressed its views on the desirability for AECB to modify its approach by putting more emphasis on risk analysis [14], it also considers that question 4 cannot and need not be answered, in the terms expressed in the Guideline. For a proper risk analysis, all possible events have to be considered. With experience, significant events can be isolated from the non-relevant ones. Still, hundreds of such events have to be analyzed. A further reduction is made possible by grouping a certain number of events and using upper bound values. According to the degree of grouping, results can be presented in different ways. For instance, one can use the AECB approach, as illustrated in Table I, but this will add nothing new. One can define a limiting risk curve and try to show that events or combinations of events are located beneath the curve. This is the approach taken by the proponent which indicated that some 126 events are respecting such a criteria; however this approach is not yet accepted by the AECB. One can also identify the most "risky" events and limit the discussion to them;

that might satisfy some observers, but certainly not those who consider that similar risks are not equally acceptable*, nor those who would imagine that the risks from ignored events may exceed the selected ones.

As can be seen from this discussion, question 3 is tricky. One should therefore concentrate on the purpose of the question and not on its actual wording. The purpose of the question seems to be in obtaining additional assurance that accident situations have been properly taken into account. Thus, one should not be surprised to see the proponent claiming that the risks are below those allowed by the AECB, nor the critics claiming that the question has not been properly answered.

4.4 Comments on the Section on Monitoring (Section 6.4)

Except for Question 1 which is difficult to interpret, all other questions are pertinent, clearly formulated and straightforward to answer.

4.5 Comments on the Section on Emergency Planning (Section 6.5)

Emergency Planning is necessary to cope with situations unforeseen by the regulatory agency (AECB). It is then impossible to reply to question 9 since, if the probabilities for such events were known and considered credible (i.e. greater than, say, 10^{-6} per year), remedial actions would have been already required. Question 9 should then be interpreted as defining levels of radioactive releases for public alert and evacuation, respectively.

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* Two activities, one resulting in a yearly fataliby of one person, the other one in 1000 casualties every 1000 years are equally risky; are they equally acceptable?

No other difficulties should be encountered with the other questions except if one would expect for a detailed answer to question 9 since the measures to be taken to protect the public are strongly dependent on the nature of the accident, on the amount and nature of radioactive releases, on the prevalent meteorogical conditions and on the expected behaviour of people under stress conditions.

4.6 Comments on the Section on Decommissioning (Section 6.6)

The author's opinion on decommissioning, as far as radiological safety is concerned, is expressed in [14]:

> "Design, construction and operation of a nuclear power plant shall be such as to facilitate its decommissioning and dismantling after its useful life with the aim of minimizing the surveillance necessary and the time before the site can be returned to a radiologically-safe condition.
>
> Plans should be outlined for the restoration of the site to a radiologically-safe condition following the end of the useful operating life of a nuclear power plant. These outline plans shall be prepared during the design and be up-dated as necessary thereafter".

While this approach does not appear to be in conflict with the E.A.P. concerns, the meaning of question 2 is difficult to interpret. Assuming that AECB regulations with regard to worker and public protection will continue to apply for the decommissioning phases of a nuclear power plant, it is clear that permissible risks will not increase while actual risks will probably decrease. In that context, trying to define "probable risks" and to describe measures to "reduce risks to acceptable levels" may become a futile exercise. Question 2 could be rephrased as to compare risks from decommissioning with risks from normal operation.

As far as question 4 is concerned, it is expressed in terms too absolute. The issue is not the period of time for reaching a complete disappearance of radiation, but for reaching a safe-level of radiation.

5. COMMENTS ON THE EIS

5.1 General Comments

The authors of the EIS, Maritime Nuclear, should be commended for submitting a well-balanced, well-written and meaningful report, of manageable length, good organization of material and directly addressing to the relevant questions of the EAS Guidelines.

This being the first Environment Impact Statement for a nuclear power plant in Canada, it sets a precedent for future EIS's. Since it covers quite a large area of topics and since it is open for public scrutiny, it can be expected to see that each intervenor will find some deficiencies as well as some unanswered questions. Many governmental agencies detain additional or more accurate information on specific topics or may want to find more answers to their concerns in other areas. Well-intentioned members of the public may require additional assurance that the construction and the operation of a second nuclear power plant at Point Lepreau will not significantly alter the present environment. Others may criticize that benefic impacts have not been properly evaluated. As a whole, however, the EIS covers, in the author's opinion, most of the ground it was expected to cover. The limited list of deficiencies in the EIS, identified by the Pannel, testifies on the overall quality of the report.

As it should have been expected, the main thrust of the report relies on environmental impacts on vegetal and animal life and on socio-economic impacts on the local population. Radiological hazards on humans are treated in less detail since the Guidelines assume that radioactive releases will respect the statutory limits imposed by the AECB. This being granted, it is surprising to find, however, so few references to substantiate statements made in relation to these hazards. A person not knowledgeable in nuclear safety may find these statements as articles of faith when, as a matter of fact, most of them can easily be proven.

5.2 Comments on Chapter 2

The description of the reactor (Sections 2.1 to 2.6) is excellent and, as far as I know, accurate. The section on radioactive waste management (Section 2.7) gives a good idea on the subject. Section 2.8 on radiological protection of workers is a good summary of the situation*.

Section 2.9 is central to the issue of risks from reactor malfunctions, but only 10 pages are devoted to this subject. The dilemma faced by the proponent is easy to understand : on one hand, a comprehensive Safety Report has to be submitted for approval by the AECB; on the other hand, it has to comply with the EAP Guidelines. He has chosen to describe the safety principles and the methodology used to ensure that safety objectives are met. He also correctly notes the similarity between Point Lepreau II and its twin brother, Point Lepreau I, which implies that only minor modifications in design and therefore in safety analysis are to be expected. However, one would have hoped for a more accurate and detailed description on how safety analysis is performed and what are the main results.

The safety principles, as stated, are an oversimplification of the real situation. Let us take the example of the independence of the special safety systems from each other and from the process systems. In the submission, the proponent states that the systems have to be totally independent.

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*Few corrections, who change little to the substance, have been pointed out in the comments prepared by the AECB.

Total independence is not possible to prove nor, indeed, necessary. "Sufficiently independent" would have been more appropriate*. Changing a single word may seem pedantic , but what is at stake is the credibility of the entire demonstration.

Another example is a statement concerning the natural events. Contrary to what is stated, it is not possible to predict the frequency and the gravity of all such events. More precisely, there is insufficient data to make predictions on events which may occur every 10 000 years or less.

An important part in the Section is taken by the classification of accidents in four categories. The purpose of such a classification is not clearly spelled out. It seems as if for each category of accidents different methodologies and criteria will be used. For someone familiar with the problems associated with the simplistic (but conservative) method presently used by the AECB, it is easy to understand the reason of the "four-category" approach. For the others, the presentation may be very confusing. Why, for instance, are the risk criteria for category A events called "pessimistic" whereas, for category B events, they are called"realistic" ? What are the criteria used for events in category D ? In its comments, the AECB, by stating that the "acceptance criteria" shown in Figures 2-12 (for category B analysis) has not been accepted, adds to the confusion. Certainly, a more complete explanation, by the proponent, would have helped in clarifying the issues.

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*Reference [14] provides a more technical definition : "Each special safety system shall ... be sufficiently physically and functionally separate from the other special safety systems and from the process systems and sufficiently diverse to ensure that cross-linked, common-cause and common-mode failures do not prevent (the special safety system to have an unavailability of 10^{-3} or less)".

As stated in Section 2 of this report, safety analysis for licensing purposes - which is different from safety analysis for risk evaluation - is undergoing in Canada a transition from the single/dual failure approach to a more probabilistic one. Until such transition is completed, the two approaches co-exist. Category A events are analyzed according to present AECB criteria. Category B events are single failure events. They could have been placed in category A events*. The problem arises from the fact that a systematic review of all possible accidents has shown that there may well be sequences of events, which do not require the intervention of the special safety systems, and which may result in releases larger than those considered acceptable according to the single failure criteria but whose probability of occurrence is so low as to contribute to an overall small risk. Hence, the claim by the proponent to consider these events "acceptable" by using "realistic" calculations and by proving that the corresponding risks are not higher than the risk derived from the AECB Siting Guide !

Category C events encompass the natural events. Probabilistic arguments apply only to frequencies higher than, say, 10^{-3} per year. For events of magnitude higher than those predicted on the basis of probability, the practice is to allow for large margins of safety. Finally, Category D events are "single" events of such low probability that they cannot be calculated in a credible way. Similarly, the consequences are difficult to evaluate. Instead of using a risk criterion for these events, the conventional approach is to use good engineering practices : quality control, periodic inspections, etc..**

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*Some are indeed, as B.44 event (pressure tube rupture).

**It should not be inferred from what preceeds that the author agrees - or disagrees - with the choice of events listed in Categories B, C and D.

In summary, while Section 2.9 may be criticized for lack of clarity, it is fair to say that it reflects present trends in the methodology of safety analysis. As far as risks are concerned, the EIS is not too explicit. By inference however, one can estimate that total risk is not expected to exceed the risk from background radiation (See also Table II).

5.3 Comments on Chapter 3

Section 3.3 describes the pre- and post-operational surveillance programs at Pointe Lepreau for environmental radioactivity. No comments will be presented here, except for noting the sensitivity of radioactive detectors which can easily spot the fall-out from nuclear explosions.

5.4 Comments on Chapter 5

This chapter deals with radioactive releases and risks associated with normal operation. Three subjects are treated : the "Derived Emission Limits" concept, or DEL, actual releases and health risks associated with an exposure to radiation.

The first concept is well described, but there was no attempt to up-date the DELs.*

Actual releases were monitored for the relevant radionuclides and results show these releases are below the target of 1% of DEL, as expected. The 40-fold increase expected when both Point Lepreau reactors reach maturity is based on experience from other reactors.

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*This deficiency has also been identified by the Panel.

Radiological health hazards are well summarized as well as the difficulty to detect effects of low-level radiation. However, in view of the fact that this subject is still controversial in the public mind, a more complete discussion, based on readily available references such as [16], would have helped dispell residual concerns.

5.5 Comments on Chapter 6

Maritime Nuclear seems to have failed in distinguishing between the two purposes of monitoring : controlling the level of radioactive (and chemical) releases, and providing assurance that predictions of insignificant changes in the background components are satisfied. Controlling means feeding-back information and taking actions according to the ratio between the intensity of a signal, and a predetermined intervention level; obviously, this can only be achieved when the signal is distinguishable from the noise (background). In addition to this "practical" purpose retained by the proponent, monitoring is also necessary to validate models used in pathway analyses. This may well mean surveillance of signals normally covered by the background.

This criticism does not necessarily imply that the proposed program is unsatisfactory nor that the Point Lepreau area should become a large environmental laboratory. It only points out that some additional monitoring may be needed for reasons unrecognized in the EIS. Obviously, it is difficult to draw a line between what is needed and what is desirable. The optimizing process has to take into account different interests as well as economic considerations.

5.6 Comments on Appendix B

Appendix B, on Decommissioning, is an uneven mixture of generalities and technical details. This is mainly due to ambiguities in the Guidelines and uncertainties associated with the solution which will be retained some 40 years from now. Scrutinizing in detail each section of this Appendix would only distract from the fact that risks during decommissioning can be kept lower than risks during the useful life of the reactor.

5.7 Comments on Appendix C

This appendix adequately describes the problem of transporting spent fuel, the criteria used in designing safe containers, the tests made with such containers and the situation in Canada. One would have hoped, however, for a more extended reference list.

5.8 Comments on Appendix D

Spent fuel disposal is a subject of world-wide concern. The Canadian program of finding the optimum solution to this problem is in high esteem in the international circles. The present status of this program is well described in this appendix. Results obtained so far confirm foreign studies which predict negligible consequences from well designed, deep burried spent fuel containers. The references, while appropriate, are not presented in the traditional way and may be difficult to find those unfamiliar with the subject.

5.9 Comments on Appendix E

In Emergency Planning, two factors are of paramount importance : a clear definition of responsibilities among the different agencies involved in the planning and non-ambiguous guidelines for different levels of intervention. It appears, from Appendix E, that these factors are very well taken into account.

One could argue on some particular measures such as the necessity of distribution of KI pills or the frequency of drill exercises, or on some aspect of the planning such as its geographical limits. In the author's opinion, little energy should be spent in discussions on optimizing measures of extremely low likelihood of occurrence.

5.10 Comments on Supporting Documents

Only a minor comment will be presented here. It is related to Supporting Document No. 2(14). This technical report reviews the seismicity at the Point Lepreau site in terms of additional earthquake record since Lepreau 1 Environmental Assessment Report and concludes that there are no reasons for major revisions to the previous results.

It would have been interesting to focus on the relationship between the frequency and the magnitude of recorded earthquakes and extrapolate the results to the area of low frequency, high magnitude events according to present understanding of seismicity in Eastern North America. This would have helped to put the 1982 event into a more proper perspective as well as indicating the degree of conservatism used in the power plant design.

6. COMMENTS ON THE LIST OF DEFICIENCIES IN THE EIS

The Environmental Assessment Panel has identified a list of deficiencies in the EIS submitted by Maritime Nuclear. As a matter of fact, some of these so-called deficiencies merely reflect a misunderstanding of the subject :

Item 4. The statement is misleading. The question does not apply to dual failures which never occurred.

Item 5. The likelihood of an event leading to a closure of food harvesting is too low to be predicted in a realistic manner.

7. COMMENTS ON THE EIS SUPPLEMENTAL INFORMATION

It is considered that information provided in the EIS Supplemental Information with respect to questions (1) to (5), (10) to (14) and (15b) is satisfactory. Additional information on health hazards from long-lived radionuclides, such as tritium and carbon-14 can be found in reference [17].

8. COMMENTS ON THE COMPENDIUM OF COMMENTS ON THE LEPREAU II EIS

In this section, only comments on few selected reports will be made.

8.1 Report of the Study Advisory Group for the Lepreau II Environmental Impact Assessment

The author fully agrees with recommendations 1 and 2; without further specification, recommendation 3 may be difficult to implement; recommendation 5 although desirable, is not necessary.

8.2 Review by Environment Canada

This document is the most thorough review of the Lepreau II EIS. The analysis is pertinent, the issues are clearly stated and the recommendations seem very reasonable. The review rises, however, two important questions : a) how much additional controls are needed (or desirable); and b) how much additional monitoring is needed (or desirable).

Environment Canada justifies its plea for additional control on the basis of the ALARA principle, but fails to include in its quotation the final part of this principle. As discussed in Section 3, the ICRP recommends to keep all necessary exposure "as low as reasonably achievable, social and economic factors being taken into account" (emphasis added). Therefore, costs of additional controls should not be compared to the construction costs without a cost-benefit analysis and without consideration of using that amount of money for other social purposes. Economic and social factors may very well point in different directions. For these reasons, recommendations (1) to (4) should be carefully evaluated.

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4. Supporting Document No. 1 (2) c- Climate of the Point Lepreau Area, New Brunswick Electric Power Commission, September 1984.

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